limited to: rooms for data processing, telecommunication switches, process control and Internet servers, banks/financial institutions, museums, archives, libraries and art collections, military and marine facilities, passenger/military aircraft, space vehicles/stations, underground/underwater facilities; marine vessels; facilities operating with inflammable/explosive materials, nuclear power plants, transportation tunnels and vehicles, apartment and office complexes, hospitals, private homes and other isolated human-occupied objects for living, working, travel, sport, entertainment and further human activities. More information will be provided on the Internet at: www.firepass.com.

CLAIMS

1. A hypoxic fire-extinguishing composition and a method for providing a breathable fire-extinguishing atmosphere in enclosed human-occupied spaces, said composition and method comprising:
a gas mixture containing oxygen and nitrogen, said gas mixture containing less than 18% of oxygen for permanent use as a fire-preventive atmosphere;
said mixture containing less than 16.8% of oxygen for episodic use as a fire suppression agent;
a process for utilizing said gas mixture by admitting it into an enclosed human-occupied space in order to create a breathable hypoxic atmosphere having fire-extinguishing properties.

2. The composition and method according to claim 1, wherein said gas mixture completely or partly replaces air in human-occupied space creating a steady breathable fire-preventive atmosphere having oxygen content above 12% and nitrogen content below 88%; said breathable atmosphere containing water vapors, carbon dioxide and other atmospheric gases in quantities acceptable for breathing;

said atmosphere receiving said composition constantly in amounts sufficient for ventilation of said human-occupied space in order to maintain breathing quality of the atmosphere;

said breathable fire-extinguishing atmosphere being applicable for fire prevention in all human-occupied enclosed spaces, including: aircraft, space station or space vehicle, underwater or underground facilities and vehicles, transportation tunnels and other isolated human-occupied objects for living, working, travel, sport, entertainment and further human activities.

3. The composition and method according to claim 1, wherein said fire suppression agent having nitrogen content below 99%; the exact content and volume are calculated in such a way that when the fire agent is released, it mixes with internal atmosphere in said enclosed human-occupied space providing breathable fire-suppressive atmosphere with an oxygen content in a range from 10% to 16% or lower, if needed;
said fire suppression agent being related for fire suppression applications in all human-occupied enclosed spaces, including: aircraft, space station or space vehicle, underwater or underground facilities and vehicles, transportation tunnels and other isolated human-occupied objects for living, working, travel, sport, entertainment and further human activities.

4. The composition and method according to claim 1 wherein said fire suppression agent containing sufficient amount of carbon dioxide for counterbalancing hypoxia in human body, so when the fire suppression agent is released, it will provide a breathable fire-suppressive atmosphere with oxygen content in a range from 10% to 16% and carbon dioxide content achieving up to 5% - 10%.

5. A composition and method for providing breathable fire-preventive atmosphere in enclosed human-occupied spaces, wherein
a breathable fire-extinguishing composition with oxygen content below 18% being used for ventilation of said human-occupied spaces (11, 91, 101, 110, 130, 140, 171, 191, 221, 241, 251, 272) in order to provide said fire-preventive atmosphere;
said composition, newly generated by an oxygen-extraction device (20, 50, 92, 102, 111, 132, 143, 173, 193, 262) or regenerated by a life-support system (223, 232, 242, 252) [;]

being provided for ventilation in quantities required for maintaining a breathing quality of said atmosphere.

6. The composition and method according to claim 5 and said composition being produced by an oxygen-extraction device employing gas separation technology in order to extract part of oxygen from ambient air.

7. The composition and method according to claim 5 and said composition being produced by said oxygen-extraction device employing molecular-sieve adsorption technology (20) in order to extract part of oxygen from ambient air.

8. The composition and method according to claim 5 wherein said oxygen-extraction device employing oxygen-enrichment membrane (50) or other air separation technology in order to extract part of oxygen from ambient air.

9. The composition and method according to claim 5 and said oxygen-extraction device additionally communicating with a high-pressure storage container (97, 104, 112, 153, 265) for providing sufficient supply of said composition that can be released in order to suppress fire when said human-occupied space does not initially contain said composition.

10. The composition and method according to claim 5, wherein said life-support system having an air-regeneration module that removes excessive moisture, carbon dioxide, dust and other gaseous products of human activity from said breathable fire-extinguishing composition;
said regeneration module constantly receiving said breathable fire-preventive atmosphere, replacing excessive carbon dioxide with oxygen and providing said breathable fire-extinguishing composition in amounts necessary to maintain breathing quality of said atmosphere;

said breathable atmosphere and composition containing a permanent ballast of nitrogen or other inert gas in a range from 83% to 88% being introduced therein initially in necessary amount that is also not affected by said regeneration module;

said ballast automatically preventing oxygen content from rising above 17%.

11. A hypoxic fire suppression agent and a method for providing a breathable fire-suppressive atmosphere in enclosed human-occupied spaces, wherein

said method applied to an enclosing structure having an internal environment (91, 101, 110, 140, 151, 201, 211, 275, 281, 301) therein containing an internal atmosphere ambient for its location and purpose, and an entry communicating with said internal environment;

said hypoxic fire suppression agent being stored in a gas storage container (97, 104, 108, 112, 122, 153, 202, 214, 265, 284, 302) and having oxygen content in a range below 16% and nitrogen; said agent may contain carbon dioxide and other atmospheric gases;

said gas storage container communicating with said enclosing structure having an internal environment (91, 101, 110, 140, 151, 201, 211, 275, 281, 301) therein containing internal atmosphere ambient for its location and purpose, and entry communicating with said internal environment;

the amount of said agent detained in or released from said container being calculated so that when the agent is released into said enclosed space, it provides a breathable fire-suppressive atmosphere having an oxygen concentration in a range from 10% to 16% and an optional content of carbon dioxide under 10%.

12. The hypoxic fire suppression agent and method according to claim 11 and

said agent being contained in said gas container at a high barometric pressure, preferably above 10 bar, and being released when a signal from a fire and smoke detecting equipment (98, 125, 159, 285, 305) is received;

said container having a release valve (107, 123, 274, 286, 311) actuated by an initiator activated by said signal;

said container having gas release nozzles (95, 106, 114, 146, 154, 175, 195, 204, 213, 268, 306) connected directly or through optional gas distribution piping (94, 105, 109, 113, 145, 152, 174, 194, 203, 212, 267, 288, 308);

said nozzles having an optional noise-reducing device in order to reduce a level of the sound from the agent release.

13. The hypoxic fire suppression agent and method according to claim 11 and

said container (97, 104, 112, 153, 265) being installed in combination with an oxygen-extraction device (92, 102, 111, 157, 262) and receiving said gas agent from it, the agent being constantly maintained under selected barometric pressure by said device and/or intermediate high-pressure compressor (103, 158, 266).

14. The hypoxic fire suppression agent and method according to claim 11 and

said container being an autonomous freestanding container (121, 202, 214) having an individual fire and/or smoke detection system that initiates release of said gas agent in case of fire.

15. The composition and method according to claim 1 wherein
said composition being used in an area selected from the group consisting of, but not limited to: rooms and enclosures for data processing and process control equipment, telecommunication switches and Internet servers; banks and financial institutions, museums, archives, libraries and art collections; dwellings and office buildings; military and marine facilities; aircraft, space vehicles and space stations, marine and cargo vessels; industrial processing and storage facilities operating with inflammable and explosive materials and compositions and other industrial and non-industrial facilities and other objects that require fire safety in human-occupied environments.

16. A composition and a process for providing breathable fire-suppressive atmosphere for transportation and communication tunnels, industrial and non-industrial buildings and structures, said composition and process comprising:

a method of use in an interior space (110, 151) restricted by a wall structure having an entry and exit, and multiple isolating partitions (115, 155) defining selected segments (A, B, C, D) of the interior space; said isolating partitions being selectively closable in case of fire so that

when closed, the segments are substantially isolated from each other and the outside environment;

said composition being produced by an oxygen-extraction device (20, 50, 111, 157) having an intake and first and second outlets, said device taking in ambient air through said intake and emitting a reduced-oxygen gas mixture, having a lower concentration of oxygen than ambient air, through said first outlet and enriched-oxygen gas mixture, having a greater concentration of oxygen than ambient air, through said second outlet;

said composition being stored in a gas storage container (112, 153) having receiving conduit and distribution conduit (113, 152) and containing said reduced-oxygen gas mixture under higher than ambient barometric pressure, said receiving conduit being operatively associated with said first outlet and receiving said reduced-oxygen gas mixture after intermediate compression therefrom;

said distribution conduit communicating with said interior space so that the reduced-oxygen gas mixture is emitted in case of fire from said container into one or multiple segments inside said interior space;

said second outlet communicating with the outside atmosphere and releasing said enriched oxygen mixture into the outside environment;

said reduced oxygen gas mixture having oxygen concentration below 16%;

said reduced oxygen gas mixture, being released inside selected segments of said interior space in case of fire and providing a breathable fire-suppressive composition with oxygen content ranging from 12% to 16%;

said composition emitting from said interior space in amounts necessary to equalize atmospheric pressure inside said interior space with the outside atmospheric pressure.

17. The composition and process according to claim 16 wherein

said multiple isolating partitions being inflatable drop curtains normally kept deflated and folded in curtain holders (116, 156) installed under ceiling throughout the interior space;

said drop curtains being made of a clear and soft synthetic material in form of inflatable flaps so when inflated, they provide a sufficient obstruction for the draft or any substantial air movements into selected segments;

said curtains being inflated by a gas from a pyrotechnical device or container initiated by a signal from the fire-detecting equipment.

18. The composition and process according to claim 16 wherein

said interior space being selected from the group comprising of rooms, houses and buildings, transportation tunnels and vehicles, underground and underwater facilities, marine vessels, aircraft, military installations and vehicles, nuclear power plants, and other human occupied objects.

19. A composition and a process for providing a constant breathable fire-preventive hypoxic atmosphere for transportation and communication tunnels, underground facilities, industrial and non-industrial buildings and structures, wherein:

said process being applied to an enclosed space (91, 101, 130, 171, 191, 272) comprising an entry, exit and a wall structure defining said enclosed space, said entry and exit having doors (131, 148, 172, 192) being selectively closable so that when closed, the enclosed space is substantially isolated from the outside environment;

said composition being provided by a gas processing device (20, 50, 92, 102, 132, 143, 173, 193, 262) having an intake and first and second outlets, said device taking in ambient air through said intake and emitting a reduced-oxygen gas mixture, having a lower concentration of oxygen than ambient air, through said first outlet and enriched-oxygen gas mixture, having a greater concentration of oxygen than ambient air, through said second outlet;

said first outlet communicating with a gas distribution piping (94, 105, 145, 174, 194, 263, 271) having multiple discharge nozzles (95, 106, 146, 175, 195, 264) inside the enclosed space so that reduced oxygen gas mixture is transmitted into said enclosed space;

said reduced oxygen gas mixture having oxygen content below 17% and above 12%;

said gas processing device comprising an air pump (24), receiving ambient air through the intake (21, 51) from the outside atmosphere, and an oxygen-extraction module (20, 50) receiving compressed air from the pump, said oxygen-extraction module having a reduced oxygen mixture conduit (23, 52) and an enriched oxygen mixture conduit (22, 53);

said first outlet being operatively associated with said reduced oxygen mixture conduit and receiving said reduced oxygen gas mixture therefrom, said second outlet being operatively associated with said enriched oxygen mixture conduit and receiving said enriched oxygen gas mixture therefrom and releasing said mixture into the outside environment;

said reduced oxygen gas mixture emitting from said enclosed space in amounts necessary to equalize atmospheric pressure inside said space with the outside atmospheric pressure.

20. The composition and process according to claim 19 and

said enclosed space being selected from the group comprising of computer rooms, houses and buildings, transportation and communication tunnels, nuclear power plants, underground and underwater facilities, marine vessels, and other non-hermetic human occupied objects.

21. The method according to claim 1 wherein said composition being generated by an apparatus comprising:
a compressor (24) and an air separation device (20, 50) having an intake (21, 51) and first (23, 52) and second outlets (22, 53), said device taking in compressed air provided by said compressor through said intake and emitting a reduced-oxygen gas mixture having a lower concentration of oxygen than said gas mixture through said first outlet and enriched-oxygen gas mixture having a greater concentration of oxygen than said gas mixture through said second outlet;

said intake being connected to a distribution valve (27, 47) providing distribution of compressed air to multiple inlets (28, 48) communicating each with an individual separation container (29) filled with a molecular sieve material that under pressure adsorbs nitrogen and water vapors, allowing enriched-oxygen gas mixture to pass through into a gas collecting tank (31) communicating with said second outlet and being operatively associated with all said separation containers and receiving said enriched-oxygen gas mixture therefrom;

each said separation container being pressurized and depressurized in cycling manner and releasing during each depressurization cycle said reduced-oxygen gas mixture being delivered into said first outlet.

22. The apparatus according to claim 21 and

said second outlet having release valve (32) allowing to keep said enriched-oxygen gas mixture being collected in said gas collecting tank (31) under increased atmospheric pressure, so when any of said separation containers depressurizes, a portion of said enriched-oxygen gas mixture is released from said tank back into said container purging said molecular sieve material from remaining nitrogen and water;

said distribution valve (27, 47) being air distribution device selected from the group consisting of electrical, mechanical, air piloted and solenoid valves, both linear and rotary configuration, with actuators controlled by pressure, mechanical spring, motor and timer;

said distribution valve being mounted on a manifold (28, 48) that is selectively communicating with said multiple separation containers (29) and said first outlet, and selectively allowing periodic access of pressurized air inside said containers and exit of said reduced-oxygen gas mixture therefrom.

23. A method for providing and automatically maintaining a breathable fire-preventive composition on board a human-occupied hermetic object, said method comprising:

an initial introduction of said composition containing oxygen and nitrogen into said hermetic object (221, 241, 251), said introduction provided by an oxygen-extraction apparatus (222) directly or via an intermediate gas storage container, so when said composition completely

replaces air inside said object and an internal atmosphere is created, the object being sealed and further air regeneration being provided by an on-board life-support system (223, 232, 242, 252);

said composition and internal atmosphere containing an inert gaseous ballast, preventing oxygen content from rising above 16.8%;

said ballast being inert gas, preferably nitrogen, that is constantly present in said internal atmosphere in a range between 83.2% and 88%;

said composition and internal atmosphere having oxygen concentration in a range from 12 to 16.8%;

said life-support system maintaining constant barometric pressure on board and regenerating said internal atmosphere by providing desired levels of oxygen, carbon dioxide and humidity, but not affecting the inert ballast content in any way.

24. The method according to claim 23 and

said hermetic object being selected from a group comprising: an aircraft, space station or space vehicle, submarine, military vehicles and facilities, underwater or underground facilities, and other isolated human-occupied objects for living, working or transport.

25. A fire suppression agent and method for providing a breathable fire-suppressive atmosphere onboard of an aircraft, wherein:

said method is applied to an aircraft interior or pressure cabin (211, 281, 301) being substantially isolated from the outside atmosphere by a wall structure with an entry, and a storage and release system for a hypoxic fire suppression agent; said storage and release system having a storage container (214, 284, 302) that contains said fire agent under pressure and communicates with the aircraft interior through a gas distribution piping (212, 288, 308) restricted by discharge valves (286, 311) and gas release nozzles (213, 286, 306);

said fire suppression agent being a mixture of oxygen, nitrogen and carbon dioxide having an oxygen concentration below 16% and carbon dioxide content above 5%; said mixture may contain other atmospheric gases;

said fire-suppression agent, being released inside said interior in case of fire, providing said breathable fire-suppressive atmosphere with oxygen content ranging from 12% to 16% and carbon dioxide content of approximately 4% to 5%, whereby an aircraft fresh air supply system is automatically shut down;

an onboard fire and smoke detection system (285, 305) that initiates the system by opening the discharge valve(s) and shutting down the aircraft ventilation system.

26 The method according to claims 25 wherein said storage and release system having a storage container (214, 284, 302) filled with said fire agent and communicating with the aircraft interior (211, 281, 301) through the gas distribution piping (212,288, 308) restricted by the discharge valve(s) (286, 306) that can be opened by an initiator actuated by a signal from the fire and smoke detection system (285, 305);

when smoke or fire being detected, the initiator opens the discharge valve(s) releasing the fire suppression agent into the aircraft interior;

the excessive amount of said fire-suppressive atmosphere being released into outside atmosphere by pressure relief valve (215, 290.310).

27. The fire-extinguishing composition according to claim 1 wherein nitrogen may be replaced in part or completely by an other inert gas or gas mixture having inert properties.

28. The method according to claim 5 wherein said breathable fire-preventive atmosphere being recycled by a split air-conditioning system (14) in order to control its temperature and humidity inside said human-occupied space.